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### Advertisement Calls of Three Species of *Bufo* (Amphibia: Anura: Bufonidae) from Lowland Bolivia

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With 3 figures and 1 table

#### Summary

Advertisement calls of three species of *Bufo* are described from lowland Bolivia. Characteristic oscillograms and sound spectrograms are provided for each species, as well as numerical information on the temporal and spectral features of the calls. The advertisement calls of *Bufo paracnemis* and *Bufo granulosus mini* are described for the first time. Call characteristics of the *Bufo margaritifera* complex are compared with previously published data. In addition, notes on the calling behaviour of each species are provided.

Keywords: Amphibia; Anura; Bufonidae; *Bufo*; advertisement calls; calling sites; calling behaviour; Bolivia.

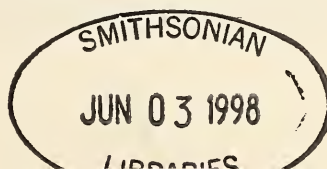
#### Resumen

– Llamadas de apareamiento de tres especies de *Bufo* (Amphibia: Bufonidae)  
de llanuras bolivianas –

Se describen las llamadas de apareamiento de tres especies de *Bufo* de llanuras bolivianas. Para cada especie se presentan un oscilograma y un sonograma, al igual que información numérica sobre las características temporales y espectrales de los cantos. Se describen por primera vez las llamadas de apareamiento de *Bufo paracnemis* y *Bufo granulosus mini*. En el caso de *Bufo margaritifera* complejo los característicos de la llamada son comparados con resultados ya publicados. Se aporta simismo información sobre el comportamiento de canto de dichas especies.

#### Zusammenfassung

Aus dem bolivianischen Tiefland werden die Paarungsrufe von drei *Bufo*-Arten beschrieben. Für jede Art werden ein Oszillogramm und Spektrogramm des Rufes abgebildet sowie numerische Daten zur Rufcharakteristik geliefert. Die Paarungsrufe von *Bufo paracnemis* und *Bufo granulosus mini* werden hier erstmals beschrieben, der Ruf von Tieren des *Bufo margaritifera*-Komplexes wird mit bereits publizierten Daten verglichen. Zusätzlich werden Beobachtungen zum Rufverhalten der Arten geschildert.



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## 1. Introduction

Bolivia includes some of the faunistically least explored areas in the Neotropics. Especially, the Bolivian herpetofauna is insufficiently known compared with its neighbouring countries. A preliminary checklist of the amphibians of Bolivia published by DE LA RIVA (1990) included 112 species. Since then numerous frog species were firstly recorded or newly described from this country. The total number of amphibian species at present known to occur in Bolivia increased to more than 180 (own data). Nevertheless, available biological information on the species is relatively poor. However, recently several publications presented data on advertisement call characteristics of Bolivian anurans, including the families Hylidae (DE LA RIVA et alii 1994, 1995, MÁRQUEZ et alii 1993), Leptodactylidae (MÁRQUEZ et alii 1995), Centrolenidae (MÁRQUEZ et alii 1996), Pseudidae (BOSCH et alii 1996), and Bufonidae (DE LA RIVA et alii 1996). The role of anuran mating calls as a pre-zygotic species isolating mechanism (e.g. BLAIR 1958, DUELLMAN 1967) makes them an important characteristic for taxonomic identification.

The purpose of the present paper is to describe for the first time the advertisement calls of *Bufo paracnemis* and *Bufo granulosus mini*, and to compare the calls we recorded in specimens of the *Bufo margaritifera* complex with published data. In addition, we provide some observations on the calling behaviour of the three species.

## 2. Material and Methods

Recordings were obtained in Bolivia in 1994 and 1995 by JK and SR. Recording equipment included Sony WM D6C tape recorders (frequency range 40 Hz–15 kHz) and Sennheiser Me-80 directional microphones with K3U modules. Used tapes were TDK SA60 and Maxell MX60 cassettes. Distance between recording position and calling individuals varied from about 0.5 to 3 meters. Settings of the recording level were done manually, no noise reduction systems were used.

Sonographic analyses were done using a Mosip-3000 sound spectrograph and Spektro 3.2 (version 1991) software (both of MEDAV GmbH, Germany). Spectrograph settings for frequency and time ranges and resolutions were chosen according to the essential structural parameters to be measured for the calls of each species. FFT width was 512 during analysis. Sampling frequency was 12.8 kHz. A representative sound spectrogram and oscillogram (FFT width 512) is presented for a 5 second recording segment for each species.

General terminology of call structure follows SCHNEIDER & SINSCH (1991), repetition rates were calculated according to method B of SCOVILLE & GOTTLIEB (1978).

Voucher specimens from recorded populations were deposited in the Colección Boliviana de Fauna (CBF), La Paz, the Staatliches Museum für Naturkunde Stuttgart (SMNS 9086 *Bufo granulosus mini*, SMNS 9091 *Bufo margaritifera* complex), and the Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK 60366 *Bufo paracnemis*).

### 3. Results and Discussion

#### 3.1. *Bufo paracnemis* Lutz, 1925

This large species (snout-vent length of adult males up to 155 mm) is distributed throughout the lowlands of southern and northeastern Brazil, Bolivia, northern Argentina, Paraguay, and southwards to Uruguay (FROST 1985). It mainly occurs in dry and open habitats, such as Cerrado formations. Calls were recorded on October 19th, 1994 at 15 road kilometers north of the village Santa Rosa de la Roca, Provincia Ñuflo de Chávez, Departamento Santa Cruz (15° 49' S, 61° 29' W). Air temperature was 25.2 °C at time of recording. Several males called in large shallow temporal ponds at night. Most specimens called from the edge of the pond but some individuals called within the water partially submerged. The minimum observed distance between calling males was about two meters. At the same pond the following anuran species called at the same time: *Hyla melanargyrea*, *H. nana*, *H. raniceps*, *Scinax fuscovarius*<sup>1)</sup>, *Leptodactylus fuscus*, and *Phyllsalaemus albonotatus*.

Advertisement calls of *B. paracnemis* were emitted at regular intervals (mean call rate 13.2 calls per min.) The call (Fig. 1) was a train of 24–40 pulse groups, emitted at a regular rate (14.11 pulse groups/sec.). One pulse group consisted of 3 pulses. Mean call duration was 2.38 (1.75–2.91) sec. Main dominant frequency was 700 Hz, and energy was distributed in the 350–900 Hz range. There is also a second power peak present at 2100 Hz.

To the best of our knowledge the only advertisement call data of this species available for comparison is an oscillogram of a single pulse group published by MARTIN (1972) without any further analysis. STRANECK et alii (1993) provided a catalogue of the voices of Argentine amphibians including tape recordings, but neither numerical parameters nor an oscillogram or spectrogram are provided by them for *B. paracnemis*.

Compared with the calls of Bolivian *Bufo poeppigii* (DE LA RIVA et alii 1996), *B. paracnemis* shows significantly longer call duration and lower dominant frequency. Calls of *Bufo marinus* from Panguana, Peru (SCHLÜTER 1981, 1984) show a similar frequency range but are shorter in duration. In both, *B. poeppigii* and *B. marinus*, a second peak in frequency power is lacking.

#### 3.2. *Bufo granulosus mini* Gallardo, 1965

This subspecies is known to occur in the Rio Beni drainage of Bolivia (GALLARDO 1965, FROST 1985). Since the publication of GALLARDO (1965), several forms considered to be subspecies of *B. granulosus* have been elevated to species rank (e.g. *B. dorbignyi*, *B. fernandezae*, *B. pygmaeus*, see FROST 1985). The same was supposed for *Bufo granulosus mini*, because areas of sympatry with the forms described as *B. g. major* and *B. g. goeldii* have been reported (FROST 1985, LAVILLA 1992). In the northern part of the Departamento Santa Cruz, Bolivia, one of us (JK) found specimens which most likely resemble the subspecies *B. g. mirandaribeiroi*. Therefore, it can be concluded that at least four forms of the *B. granulosus* complex (*goeldii*, *major*, *mini*, *mirandaribeiroi*) occur in Bolivia. It is very probable that some of them

<sup>1)</sup> We herein follow KÖHLER & BÖHME (1996), who provided evidence for the masculine gender of *Scinax*.

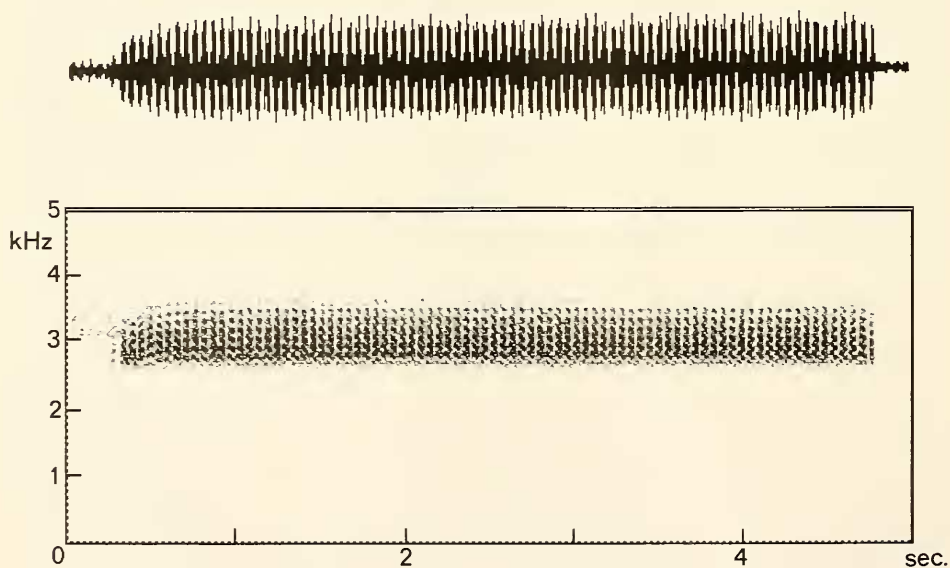
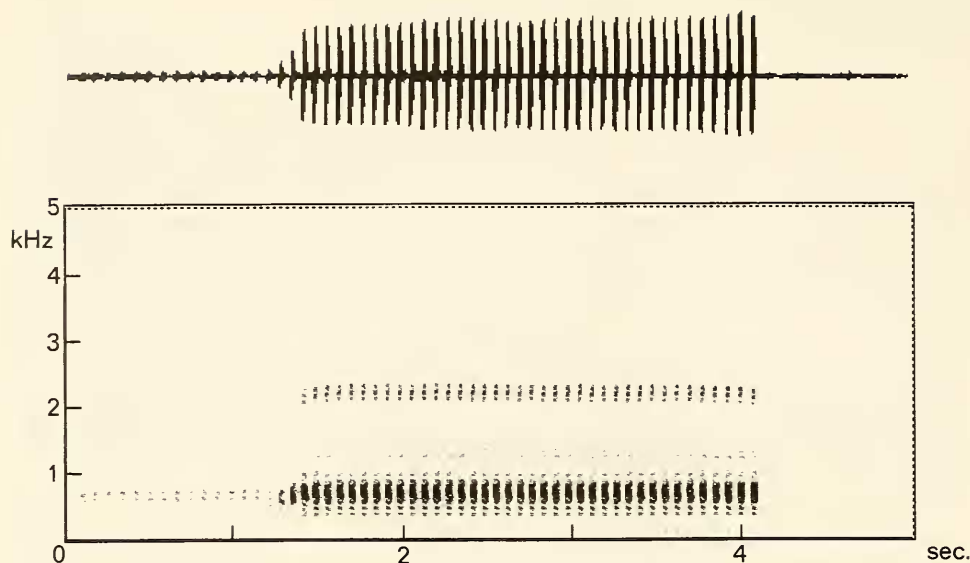


Fig. 1 (above). Sound spectrogram (bottom) and oscillogram (top) of a 5.0 s section of a characteristic advertisement call of *Bufo paracnemis*, recorded at 15 km N of Santa Rosa de la Roca, Bolivia (air temp. 25.2 °C).

Fig. 2 (below). Sound spectrogram and oscillogram of a 5.0 s section of a characteristic advertisement call of *Bufo granulosus mini* recorded at El Porvenir, EBB, Bolivia (air temp. 24.5 °C).



share areas of sympatry. In this case these forms would represent distinct biological species. However, the knowledge of the distribution of the different forms occurring in Bolivia is still very poor and we therefore refrain here from a formal elevation of *Bufo granulosus mini* (or other mentioned subspecies) to species rank.

Advertisement calls of *Bufo granulosus mini* were recorded at El Porvenir, Estación Biológica del Beni (EBB), Provincia Yacuma, Departamento Beni (14° 38' S, 66° 18' W), in October 1994. Air temperature was 24.5 °C at time of recording. Several males called from the edge of small vegetation-free puddles or within the water, partly submerged, in open habitat. The individuals usually called in large choruses. Other anuran species calling at the same site at the same time were: *Scinax ruber*, *Phyllomedusa hypocondrialis*, *Leptodactylus leptodactyloides*, and *Elachistocleis bicolor*.

The call (Fig. 2) was a high-pitched train of 75–133 pulse groups, emitted at regular intervals (18.34 pulse groups/sec.). Each pulse group consisted of 6 pulses. Mean call duration was 5.28 (4.1–7.5) sec. Mean dominant frequency was 2960 Hz, with an energy range between 2500 and 3900 Hz.

For the advertisement calls of Amazonian populations of *B. granulosus* from the vicinity of Manaus, Brazil, ZIMMERMAN (1983) published a mean dominant frequency of 2100 Hz and a repetition rate of 135 pulses per sec., without referring the individuals to a subspecies. In spite of their small size (mean snout-vent length 25.4 mm) this dominant frequency is significantly lower than the one reported here for specimens from Bolivia with a mean SVL of 34.5 mm. To our knowledge, there is no other numerical information available for comparison.

### 3.3. *Bufo margaritifer* complex

According to HOOGMOED (1989, 1990) the toads usually recognized as *Bufo* “*typhonius*” represent a complex of species the proper name of which is *Bufo margaritifer* complex. HOOGMOED (1990) mentioned Bolivian populations of the complex to be an undescribed species. We therefore use here the name *Bufo margaritifer* for Bolivian populations only tentatively (compare DE LA RIVA et alii 1996).

Advertisement calls of *B. margaritifer* were recorded near Totaizal, Provincia Yacuma, Departamento Beni (14° 39' S, 66° 18' W), in February 1995. Air temperature was 24.7 °C at time of the recording. Males formed choruses around and in small ephemeral puddles within secondary forest. The only synchronously calling species at this site was *Bufo granulosus mini*.

The call (Fig. 3) consists of a train of 7–8 pulse groups, emitted at regular intervals (24.9 pulse groups/sec.). Mean call duration was 316 ms (291–339 ms). The pulse groups were composed of 1–4 pulses. Usually, only the last pulse group within the call consists of 4 pulses, whereas the others mostly consist of 2 pulses. The mean dominant frequency in our recordings was 1140 Hz, with an energy range between 750 and 1450 Hz.

Compared with call characteristics of *B. margaritifer* from Departamento Santa Cruz, Bolivia, published by DE LA RIVA et alii (1996) our results differ somewhat only in respect of lower dominant frequency. The value we found is approximately 200 Hz lower (1140 Hz versus 1332 Hz) but this difference could be due to size differences of the frog individuals recorded. This indicates that these recorded Bolivian populations belong to the same species which might be widely distributed through-

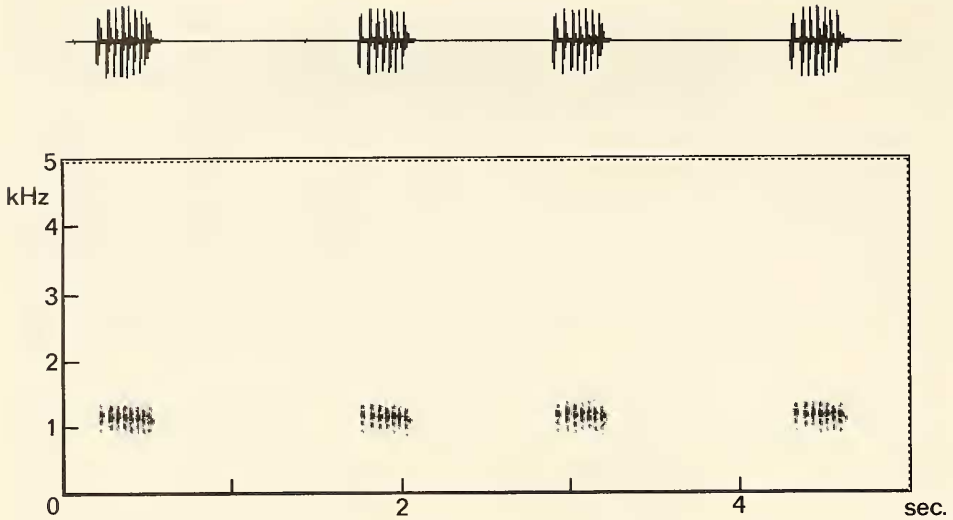


Fig. 3. Sound spectrogram and oscillogram of a 5.0s section of a characteristic advertisement call of a specimen of the *Bufo margaritifer* complex, recorded near Totaizal, Bolivia (air temp. 24.7 °C).

Tab. 1. Summary of the structural call characteristics (mean  $\pm$  SD, range) of *B. paracnemis*, *B. granulosus mini* and *B. margaritifer* complex.

	<i>B. paracnemis</i>	<i>B. granulosus mini</i>	<i>B. margaritifer</i>
Air temperature (°C)	25.2	24.5	24.7
Individuals analyzed	1	1	2
Calls analyzed	13	5	6 + 3
Call duration (ms)	2379 $\pm$ 276 1747 – 2912	5276 $\pm$ 1409 4100 – 7530	316 $\pm$ 15 291 – 339
Dominant frequency (kHz)	0.7 $\pm$ 0 0.7	2.96 $\pm$ 0.06 2.91 – 3.04	1.14 $\pm$ 0.01 1.13 – 1.15
Pulse groups/call	33.2 $\pm$ 3.9 24 – 40	96.4 $\pm$ 23.5 75 – 133	7.9 $\pm$ 0.6 7 – 8
Pulses/pulse group	3 $\pm$ 0 3	6 $\pm$ 0 6	2.0 $\pm$ 0.73 1 – 4
Pulse groups/second	14.11 $\pm$ 0.07 14.0 – 14.2	18.34 $\pm$ 0.43 17.66 – 18.73	24.93 $\pm$ 1.08 23.19 – 26.55
Pulses/second	84.1 $\pm$ 3.24 79.5 – 90.2	139.53 $\pm$ 4.78 134.5 – 145.8	97.9 $\pm$ 15.62 84.8 – 125.7
Pulse group duration (ms)	34.73 $\pm$ 0.99 33 – 40	42.68 $\pm$ 1.46 40 – 48	20.25 $\pm$ 5.35 14 – 41
Calls/minute	13.2 $\pm$ 2.81 11.2 – 18.1	6.83 $\pm$ 1.07 5.66 – 8.35	82.52 $\pm$ 1.66 80.9 – 84.9

out the Bolivian lowlands. However, we found a specimen of the *B. margaritifer* complex (ZFMK 60464) at 1860 m above sea level (112 km, Cochabamba – Villa Tunari road, Depto. Cochabamba) within humid montane forest. REYNOLDS & FOSTER (1992) found specimens at a nearby locality at 1967 m a.s.l. It can not be excluded, however, that these montane forest populations are distinguished from lowland populations and possibly represent a distinct species.

#### 4. Acknowledgements

We are indebted to the Colección Boliviana de Fauna (CBF), La Paz, and the Estación Biológica del Beni (EBB) for cooperation and permissions. Thanks are also due to Sennheiser electronic KG (Wedemark, Germany) for the loan of sound recording equipment.

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